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OPTICAL PROCESSING DEVICE

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s on this receipt should be addressed to Janine Geran, tel. 01633 814570. All other enquiries ected to Central Enquiry Unit, tel. 0845 9 500 505.

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OPTICAL PROCESSING DEVICE

This invention relates to an optical processing device arranged to separate a plurality of signals received at an input into separate signals at a plurality of outputs and to a sensor array for use therewith.

Known optical processing devices such as arrayed waveguide gratings (AWGs) and de-multiplexers are mounted within a housing and have their outputs connected to sensors external of the housing via optical fibres. This results in a cumbersome device which is expensive to manufacture and which is subject to fabrication errors.

The present invention aims to overcome or at least reduce these disadvantages.

According to a first aspect of the invention, there is provided an optical processing device arranged to separate a plurality of signals received at an input into separate signals at a plurality of outputs, the device being integrated on a chip and having light sensing means mounted on or adjacent the chip for receiving signals directly from said plurality of outputs.

According to another aspect of the invention there is provided a sensor array comprising a plurality of photodiode sensors mounted along an elongate support member, each photodiode having an anode and a cathode, a first metal track being provided on the support member for connection to the cathodes of the plurality of diodes and a plurality of further metal tracks on the support member, each further metal tracks being electrically connected to the anode of a respective photodiode.

Preferred and optional features of the invention will be apparent from the following description and from the subsidiary claims of the specification.

The invention will now be further described, with reference to the accompanying drawings in which:

Figure 1 is a schematic perspective view of an AWG according to one embodiment of the first aspect of the invention;

Figure 2 is an enlarged, schematic view of a part of a sensor array used in the AWG shown in Figure 2 which also comprises an embodiment of the second aspect of the invention;

Figure 3A is a front view of the sensor array and figure 3B is a plan view of the sensor array of a preferred embodiment of the invention;

Figure 4 is an exploded view of the AWG of Figure 1.

Figure 1 shows an AWG device fabricated on a chip 1. A plurality of signals of different wavelengths is received by an input waveguide 2 from an optical fibre 3. The input waveguide 2 leads to a free space region 4 in which the input signals are divided between a plurality of waveguides 5 making up the AWG. A further free space region 6 is provided at the output end of the AWG and a plurality of output waveguides 7 are connected thereto. The AWG is arranged in a known manner such that each of the output waveguides 7 receives one of the plurality of signals, each being of a different wavelength.

Light output from the output waveguides is directed towards a sensor array 8 mounted on or adjacent the chip 1. The sensor array comprises a plurality of light sensors, eg InGaAs photodiodes, mounted in a line along a side face of a ceramic support member 10 at a pitch of about 250 microns. As shown in the enlarged view of part of the sensor array in Figure 2, a first metal track 11 is

provided on the member 10 for connection to the cathodes of each of the photodiodes 9 and further metal tracks 12 are provided on the member 10, each for providing an electrical connection to the anode of one of the photodiodes 9. The first metal track 11 is electrically connected to the cathodes of the photodiodes 9 by direct contact with the cathodes on the underside of each photodiode 9. The further metal tracks 12 are electrically connected to the anodes of the photodiodes by wire bond connections 13.

The metal tracks 11 and 12 may be formed of gold or other material suitable for wirebonding such as a TiWAu alloy.

In another arrangement, the anodes and cathodes may be interchanged.

As shown in Figure 2, each of the metal tracks 11 and 12 wraps around a corner of the member 10 so that further wire bond connections 14 can be made to the portions of these tracks on an upper face of the member 10.

The above arrangement may be used to monitor the power level of each of 40 (or more) dense wavelength division multiplexing (DWDM) channels, the output of the photodiodes 9 being used for system control and monitoring purposes. The photodiodes 9 are preferably top entry photodiodes, ie with a light receiving port on a surface adjacent the anode connection. The photodiodes 9 are mounted on the ceramic support member 10, eg by means of conductive epoxy resin or solder, with their cathodes in contact with the metal track 11 and their light receiving ports facing away from the member 10. The photodiodes 9, which are typically formed on a InGaAs chip, may be provided in a strip or bar comprising, for example, 40 photodiodes. Alternatively, several shorter strips, eg two strips of 20 photodiodes may be used as this helps improve the yield in fabrication of the strips although additional alignment and fixing costs will be incurred in mounting the strips on the member 10 in alignment with each other. A greater number of channels can also be catered for, eg 80 channels, using

eight strips of 10 photodiodes, four strips of 20 photodiodes, two strips of 40 photodiodes or one strip of 80 photodiodes.

Where multiple strips of photodiodes are used, the output waveguides may also be formed in corresponding groups, eg of ten or twenty waveguides, preferably with a larger gap between groups to allow for the larger spacing between the end diodes of adjacent strips.

The ceramic support member may be mounted on the chip 1, eg within a recess (not shown) provided at the edge thereof or to the edge of the chip with the photodiodes within close proximity, eg within a few microns, of the end faces of the output waveguides 7. However, the chip 1 and member 10 are preferably both mounted on a ceramic support block 15 (see Figure 4) with the photodiodes 9 approximately 10 to 20 microns from the end faces of the output waveguides 7. In either case, the photodiode array 8 is actively aligned with the output waveguides 7. It will also be appreciated that, in both cases, the photodiodes 9 are positioned to receive signals directly from the waveguides 7, ie without the need for an optical fibre therebetween, as they are mounted in close proximity to the outputs of the waveguides 7. This also provides a low loss connection between the waveguides 7 and the photodiodes 9, typically of less than –0.2dB.

The wire bond connections 13 are preferably designed so as not to interfere with the positioning of the photodiodes 9 in close proximity with the end faces of the output waveguides 7. The wirebond connections 13 preferably lead off from a face of the photodiodes 9 from points slightly above the light receiving ports so that the wirebonds do not foul the edge of the chip 1 when this is brought into close proximity with the diode array.

The end faces of the output waveguides 7 are preferably angled so they are not perpendicular to the waveguide axis in order to help reduce back reflections at

the end faces. Similarly, the end face of input waveguide 2 may be angled so as not to be perpendicular to the optic axis.

Figure 3A shows a front view of the photodiode sensor array showing the array 8 of photodiodes mounted on the support 10, the metal tracks 12 and the wire bonds 13 connecting the photodiodes 9 to the metal tracks 12. As shown in this view, the metal tracks 12 diverge from each other as they extend across the front face of the member 10 and they then pass around an edge of the support 10 onto the top surface thereof a plan view of which is shown in Figure 3B. The tracks 12 diverge further from each other as they extend across the top surface of the support 10. The tracks 12 terminate in pads 12A to which further wirebond connections (not shown) can be attached. As the tracks 12 diverge from each other, the spacing between these pads 12A is greater than that between the photodiodes 9, and the pads 12A may be made larger, eg 0.2mm x 0.2mm, so making it easier to connect wire bonds 14 (see Fig 2) thereto without short circuiting adjacent.

The chip 1 is preferably a silicon chip, eg a silicon-on-insulator chip. The waveguides 2, 5 and 7 can thus be formed as rib waveguides. The use of silicon, as opposed to a material such a silica, is advantageous as, due to the relatively high refractive index of silicon, light is tightly confined within the rib waveguides. The waveguides can thus be formed closer together than in the prior art due to the reduced cross-talk between channels. The AWG can thus be made more compact than known devices. The situation can be further improved if optical isolation features are provided between the waveguides. However, in some circumstances, a silica chip, or other type of integrated optical chip, may be used.

Figure 4 shows a perspective, exploded view of a preferred arrangement of the AWG device. As mentioned above, the chip 1 and ceramic support member 10 are mounted on a support block 15. A heater and heatspreader 16, such as a resistive heater mounted in close proximity to the chip 1 (particularly under the

region where the AWG waveguides 5 are provided) to maintain the chip 1 at a constant temperature (eg to within ± 0.1 degree C) over the life time of the product. A thermistor 17 is provided on the chip 1 to sense the temperature thereof. A support layer 18, eg of ceramic, is provided beneath the heater 16.

The input optical fibre 3 is connected to the input waveguide 2 on the chip 1 via a fibre-block 19.

The whole device is mounted within a housing such as a hermetic Au/Ni plated Kovar (Trade Mark) package (not shown) with a single fibre pigtail for the input fibre 3.

The arrangement described above thus enables the device to be constructed entirely within a package without the need to connect to externally packaged photodiode sensors. The sensor array provides a low loss connection with the AWG and fabrication of the device is relatively easy and quick. It also provides greater uniformity between the channels than in the prior art. It also allows the outputs of all waveguides 7 to be monitored continuously.

CLAIMS

1. An optical processing device arranged to separate a plurality of signals received at an input into separate signals at a plurality of outputs, the device being integrated on a chip and having light sensing means mounted on or adjacent the chip for receiving signals directly from said plurality of outputs.
2. A device as claimed in claim 1 in which the light sensing means comprises at least one array of light sensors mounted on a common support.
3. A device as claimed in claim 1 or 2 comprising an input waveguide for receiving the plurality of signals and a plurality of output waveguides integrated on the chip.
4. A device as claimed in claim 1, 2 or 3 which comprises an arrayed waveguide grating integrated on the chip.
5. A device as claimed in claim 2 in which the sensor array is mounted on the chip in close proximity with output faces of the output waveguides.
6. A device as claimed in claim 2 in which the chip and the sensor array are each mounted on a support with the sensor array in close proximity with output faces of the output waveguides.
7. A device as claimed in any preceding claim arranged to separate at least 40 signals and to monitor the power level thereof.
8. A device as claimed in any preceding claim in which the grating is integrated in a silicon chip.
9. A device as claimed in claim 8 in which the chip is a silicon-on-insulator chip.
10. A device as claimed in claim 2 and claim 8 or 9 in which the waveguides are silicon rib waveguides.
11. A device as claimed in any preceding claim in which the sensor array comprises a plurality of photodiode sensors mounted along an elongate support member, each photodiode sensor having an

anode and a cathode, a first metal track being provided on the support member for connection to the cathodes of the plurality of photodiode sensors and a plurality of further metal tracks on the support member, each further metal tracks being electrically connected to the anode of a respective photodiode sensor.

12. A device as claimed in claim 11 in which the photodiode sensors are mounted on a side face of the support member and the first metal track and/or the further metal tracks extend around an edge of the support member onto a top face thereof.

13. A device as claimed in any preceding claim in which the further tracks diverge from each other as they extend away from the sensor array.

14. A device as claimed in claim 2 or any claim dependent thereon in which the or each sensor array comprises ten or more light sensors on a common support.

15. A device as claimed in any preceding claim in which the chip and the sensing means are mounted within a hermetic package.

16. A sensor array comprising a plurality of photodiode sensors mounted along an elongate support member, each photodiode sensor having an anode and a cathode, a first metal track being provided on the support member for connection to the cathodes of the plurality of photodiode sensors and a plurality of further metal tracks on the support member, each further metal track being electrically connected to the anode of a respective photodiode sensor.

17. An optical processing device substantially as hereinbefore described with reference to the accompanying drawings.

18. A sensor array substantially as hereinbefore described with reference to the accompanying drawings.

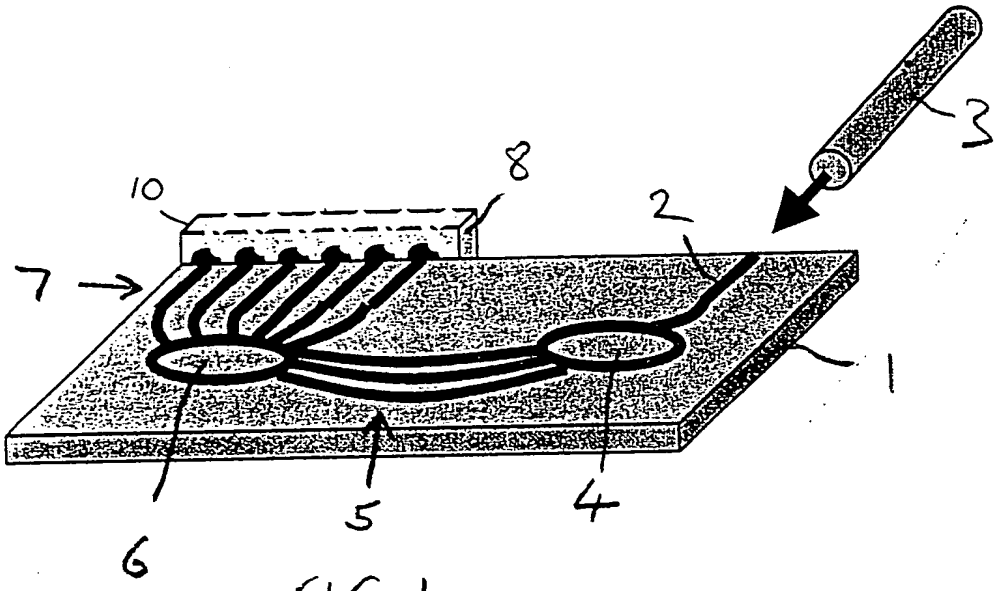

FIG. 1.

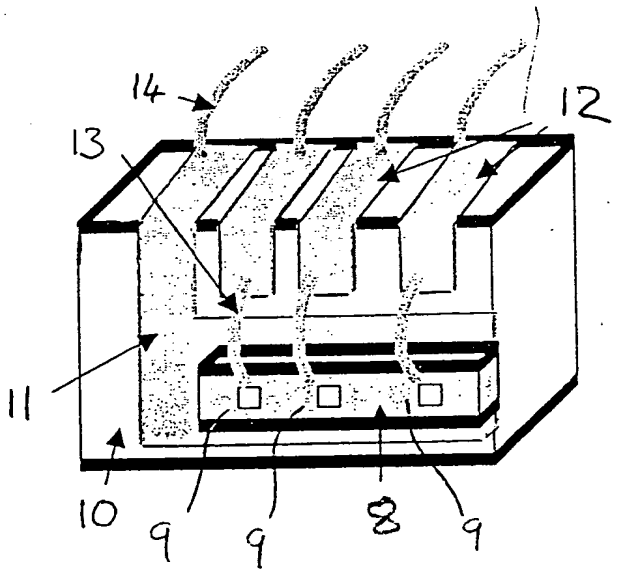

FIG. 2.

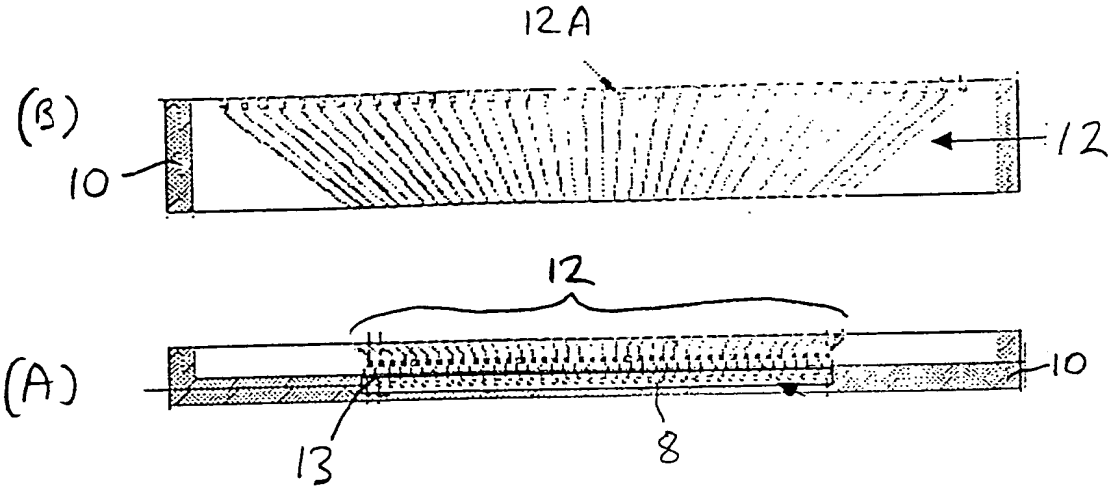

FIG. 3.

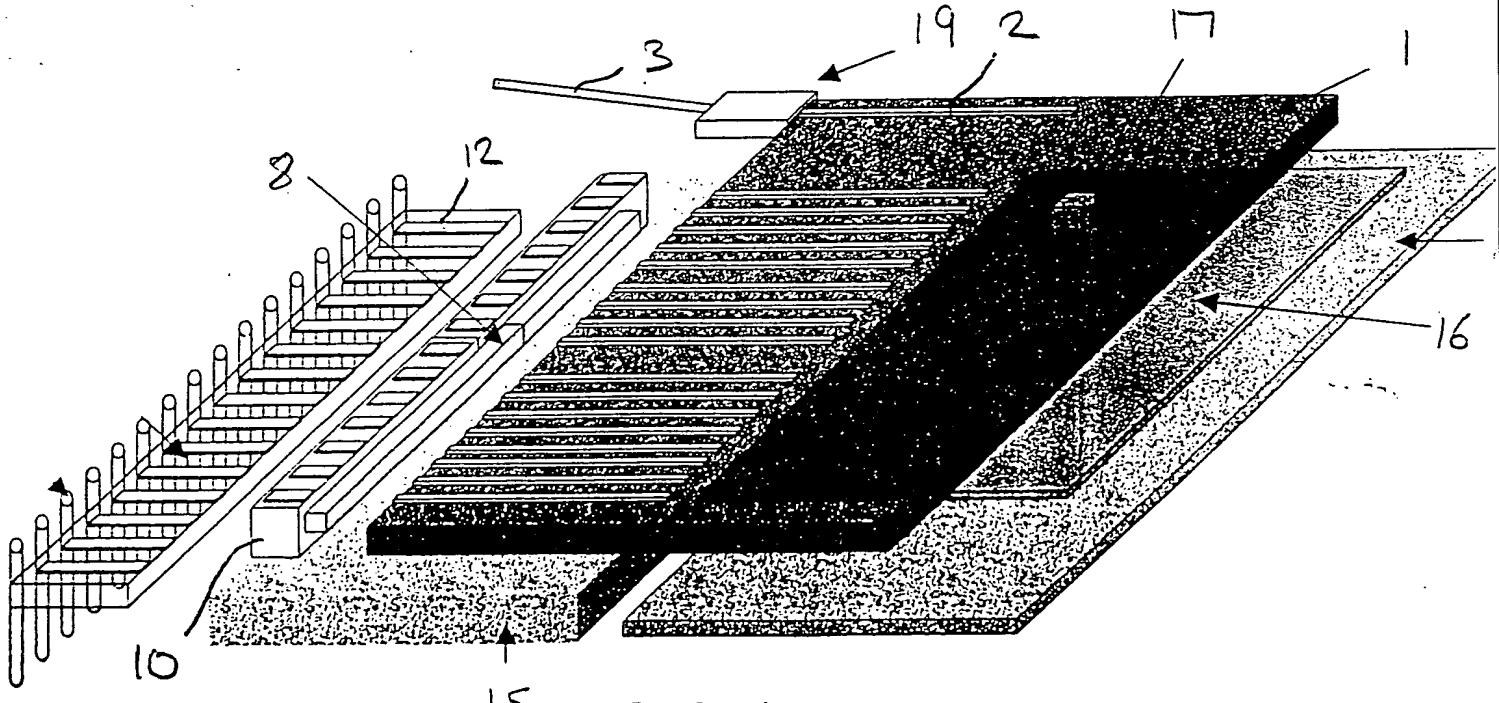

FIG. 4.